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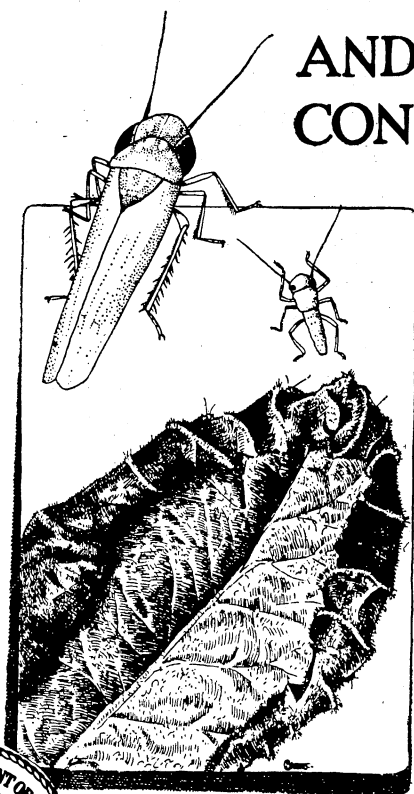
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# U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1462

## THE POTATO LEAFHOPPER

AND HOW TO  
CONTROL IT



**T**HE POTATO LEAFHOPPER is a very small green insect which often occurs in vast numbers. It is a serious and costly enemy of potatoes, beans, and other crops in the North-Central and Northeastern States.

It injures potatoes by feeding on the foliage, and causes a diseased condition called hopperburn, which, under conditions favorable to its spread, may ruin an entire crop in one or two weeks.

This leafhopper can be controlled and the hopperburn held in check by the proper and timely application of Bordeaux mixture. Yields are greatly increased when this spray is used.

This bulletin has been prepared to acquaint the grower with the insect, the nature of its injury to vegetable crops, and the proper measures for its control. It is a revision of and supersedes Farmers' Bulletin 1225, The Potato Leafhopper and Its Control.

# THE POTATO LEAFHOPPER AND HOW TO CONTROL IT

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**T**HE POTATO LEAFHOPPER<sup>1</sup> is one of the most important insect enemies of the potato in the United States. Serious outbreaks have occurred periodically in certain sections since the early eighties, and about 1896 this insect became known as a menace to the potato crop in the Middle and Eastern States. This leafhopper attacks a large variety of plants and may at times become injurious on several of them.

The feeding injury, although severe, is not nearly so serious as the diseased condition called "hopperburn," which appears on the plants on which the leafhopper feeds.

It is necessary to recognize this leafhopper in order to be prepared to control it and to prevent the loss of large acreages of potatoes from hopperburn.

## DESCRIPTION

The adult or full-grown leafhopper (fig. 1 and fig. 2, G) is a very small, pale-green insect, about one-eighth of an inch long, with prominent white markings. It has a more or less distinct H on its body between the head and base of the wings. There



FIG. 1.—Adult potato leafhopper. Greatly enlarged

<sup>1</sup> *Empoasca mali* LeB., order Hemiptera, family Cicadellidae.

are six roundish white spots above this H and three white, wedge-shaped spots below it. Adults fly and hop readily when disturbed.

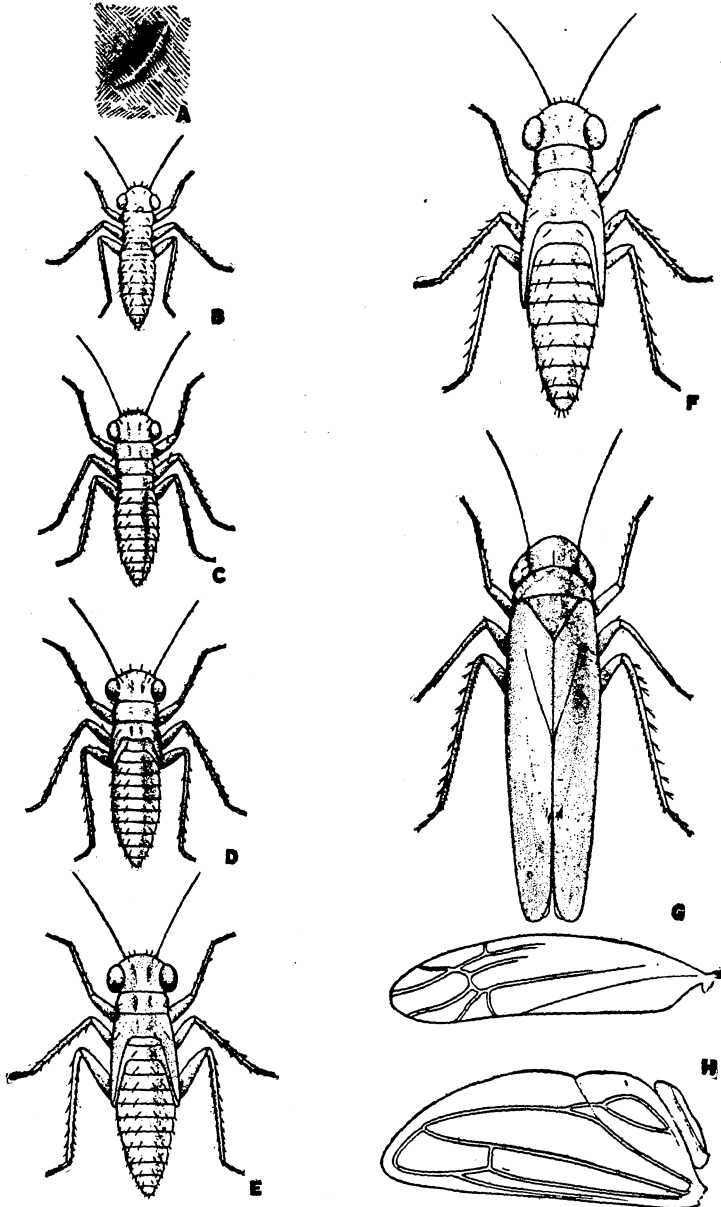


FIG. 2.—Stages in the growth of the potato leafhopper: A, Egg in tissue of leaf; B–F, stages of young leafhopper or nymph; G, adult leafhopper; H, fore and hind wings of adult leafhopper

The eggs (fig. 2, A) are tiny and transparent. They are laid in the tissue of the potato leaf and are invisible from the outside, but after they hatch the leaf tissue dies and forms small, sunken pits marking the previous location of the eggs.

The nymphs (fig. 2, B to F), or young leafhoppers, pass through five stages of growth and shed their skins each time, developing wings in the adult stage. When newly hatched, the nymphs are very small and nearly white, but slowly turn green as they grow. When the insect is nearly mature, the partially developed wings may be seen on each side of the body. At this stage the nymph is very active, being able to hop from leaf to leaf.

#### DISTRIBUTION

The potato leafhopper occurs in practically every State of the Union, in parts of Canada and Mexico, and in South America. Its greatest damage to potatoes has occurred in the Northern and Central States, roughly from Montana to New York, and south to Ohio, Illinois, and Kansas.

#### ECONOMIC IMPORTANCE

The economic loss to the potato grower caused by the attack of the potato leafhopper and the accompanying hopperburn is probably greater than that caused by any other potato insect. The loss caused by its attack on certain other crops, notably beans, is considerable. As the insect appears in injurious numbers periodically and as injury caused by it may spread very rapidly under favorable weather conditions, it is essential that the grower be equipped and ready to cope with an outbreak before it has threatened his crop.

#### SEASONAL HISTORY

The potato leafhopper lives over the winter in the adult stage, hidden away in brush heaps, matted dead vegetation such as weeds, and other protected places. From May 1 to 15, according to the season, leafhoppers emerge from their winter quarters, feed for a week or so on various trees and shrubs, then migrate suddenly to potatoes and beans, where mating and egg laying begin. This definite migration usually takes place the first week in June. Adults of the first generation, appearing the last of July and the beginning of August, migrate to some extent from early to late potatoes. The time and extent of this migration are determined by the temperature and the condition of the vines upon which they have bred. In this way late-planted potatoes become infested. There are two generations of the insect each year in the Northern States.

Under conditions in Wisconsin the adults which have lived through the winter die off in July and their young mature about the last of July, forming the first generation. Thus it takes approximately one month from the time the eggs are laid until the adult leafhoppers appear. A second generation is now produced, although in a slightly longer time, and the new adults begin to appear early in September. These adults live through the winter and do not lay eggs until the next spring.

#### HOPPERBURN

Adults and nymphs of the potato leafhopper suck the juices or sap of plants by means of their delicate beaks, which they insert into

the leaves. The injury thus caused through loss of plant juices must of itself be considerable when a large number of leafhoppers are present.

In addition to the injury caused by loss of plant juices, however, this leafhopper is the cause of a distinct injury called "hopperburn," which follows its feeding on potato and many other plants (fig. 3).

The first symptoms of hopperburn are a slight yellowing, usually of the tip of a leaflet. As the disease progresses, the leaflet slowly turns brown, curls upward, and dies. The diseased condition spreads from the tip or margin toward the midrib of the leaflet, but spreads

more slowly toward the base, and the basal area of leaves may remain green until the whole plant is nearly dead.

During periods of hot, dry weather leafhoppers reproduce very rapidly; the females are stimulated to lay eggs faster and the nymphs develop in a shorter time. Thus, with a constantly increasing population, hopperburn spreads very rapidly. The effect of hopperburn combined with the effect of dry weather may kill whole fields of early potatoes in a week's time (fig. 4). On the other hand, during cool, moist weather, which slows down the increase of leafhop-



FIG. 3.—Potato leaf affected with hopperburn. Upper surface of leaf, showing typical upcurled brown tip and margin

pers, and especially where protective sprays have been applied, the disease is checked, and throughout the summer it may progress no farther than the primary symptoms (fig. 5).

Observations made in Wisconsin have shown that whenever leafhoppers were present in potato fields hopperburn could be found, and that when no leafhoppers were present no hopperburn could be found. In other words, the leafhoppers and hopperburn are always found together.

#### HOW HOPPERBURN AFFECTS DIFFERENT VARIETIES

Leafhoppers placed on Early Triumph potato plants growing in a field and covered with a large cage caused hopperburn, which killed the plants in 23 days (fig. 6, A and B). Leafhoppers placed

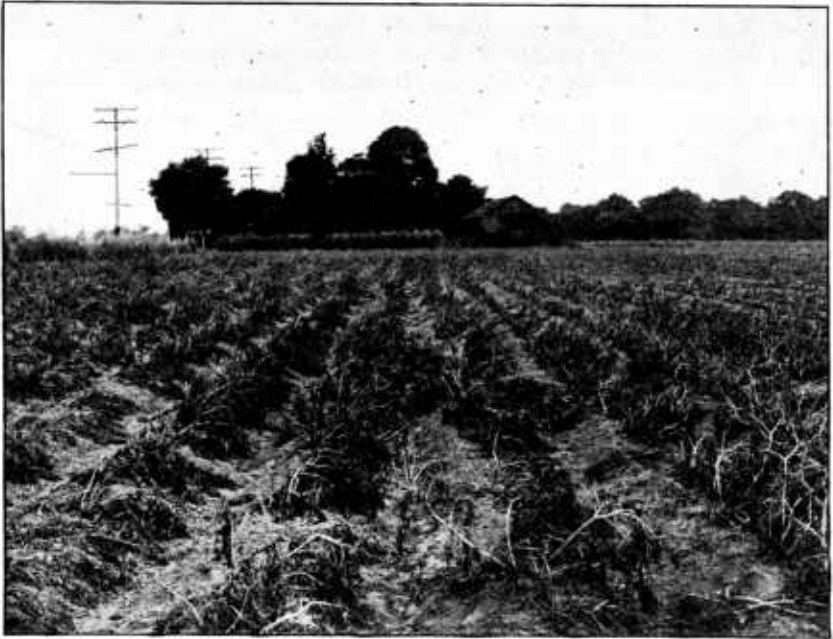


FIG. 4.—Early Ohio potatoes killed by hopperburn. Great abundance of leafhoppers and a period of hot, dry, July weather caused these potatoes to succumb to hopperburn in a short time



FIG. 5.—Main-crop potatoes protected from hopperburn by Bordeaux mixture. Two sprayings with Bordeaux mixture kept this field fairly free from hopperburn

on Early Ohio plants under the same conditions caused hopperburn, which killed the plants in about 40 days. Similarly, hopperburn killed Irish Cobbler plants in about 55 days and Rural New Yorker plants in about 50 days. Green Mountain potatoes under like con-

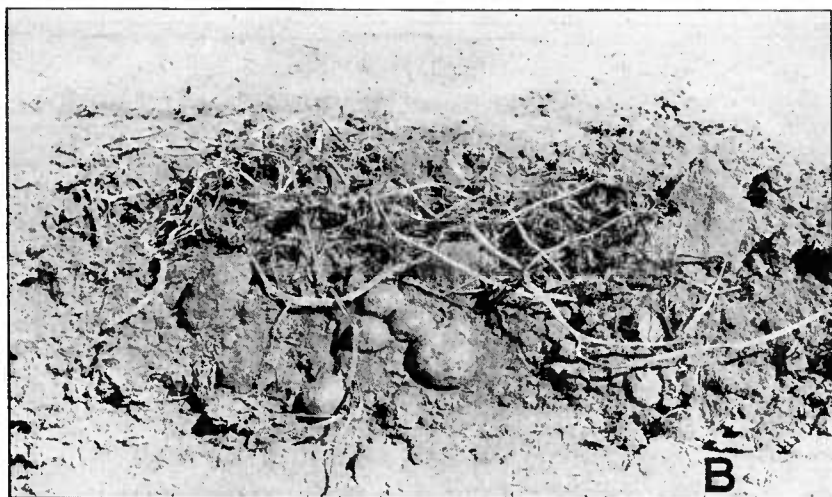


FIG. 6.—Presence of many leafhoppers means hopperburn. Triumph potatoes growing in field, covered with large cage containing leafhoppers for entire season. A, Condition of plants on August 14; B, condition of same plants when dug on September 2. Compare with Figure 7

ditions became badly diseased, but were still alive two months after the leafhoppers were placed on them.

Plants of all the foregoing varieties which were confined and kept free of leafhoppers showed no symptoms of hopperburn during a period of two months (fig. 7, A and B).

Observations made in several potato-growing sections of Wisconsin have shown that the Triumph variety is invariably more severely affected with hopperburn than any other variety grown commer-



FIG. 7.—Absence of leafhoppers means no hopperburn. Triumph potatoes growing in field, covered with large cage for entire season and kept free of leafhoppers. A, Condition of plants on August 14; B, condition of same plants when dug on September 2. Compare with Figure 6

cially in that State. Usually the Rural New Yorker has been found to be the most resistant to hopperburn of any variety grown commercially in Wisconsin.

## FOOD PLANTS

The potato leafhopper visits a considerable number of plants for feeding purposes. The more important economic plants on which reproduction takes place and hopperburn occurs are the following: Potato, beans (practically all varieties), sugar beet, hemp, apple, and raspberry. It also attacks several ornamental trees and shrubs. Reproduction appears to take place most readily on potato, with beans as a second choice. Hemp, sugar beets, and apple nursery stock are more liable to severe injury when growing near potato or bean fields.

String, pole, and navy beans are at times severely injured by hopperburn, and if the plants are not killed outright the yields are greatly reduced. Lima beans and soybeans are not so heavily attacked, nor is hopperburn ever severe on them; this is the case in Wisconsin, at least.

Not only are certain varieties of potatoes less severely affected with hopperburn than are others, but some plants of any one variety are found to be more resistant to hopperburn than are other plants of the same variety.

## NATURAL ENEMIES

Although there are three known natural enemies of the potato leafhopper, none has become important as a control. One, a tiny insect parasite, breeds in the leafhopper eggs, but does not occur in sufficient numbers to reduce noticeably the number of leafhoppers.

A fungous disease attacks both adults and nymphs, or young. Leafhoppers affected with fungus<sup>2</sup> soon die and turn from green to yellowish in color. In a short time a heavy fungous growth, having colors of the rainbow, appears on the insect's body (fig. 8). Warm, moist weather is necessary for the growth and spread of this fungus. In 1919 it was common all over Wisconsin, and in certain localities practically exterminated the leafhoppers. In 1920, however, not a single specimen of the fungus was found. From 1920 to 1923 it has occurred sporadically, but has not been a factor in control. Spiders often prey on both adults and nymphs, or young.

## CONTROL OF THE LEAFHOPPER AND PREVENTION OF HOPPERBURN

The results of six years' experiments show that Bordeaux mixture controls the leafhopper, killing many of the nymphs, or young, and repelling the adults. It is the best-known remedy for the prevention of hopperburn.

Bordeaux mixture combined with nicotine sulphate acts a little more quickly in ridding plants of leafhoppers than does Bordeaux alone, but the results obtained do not appear to justify the added time and expense of using the nicotine.

Nicotine sulphate combined with soap has been found very effective in killing nymphs, or young, and the few adults present at the time when the spray was applied. There was no lasting effect, however, because leafhoppers reappeared in a few days. Hopperburn was not controlled.

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<sup>2</sup> *Entomophthora sphaerosperma*.

Kerosene emulsion acted in the same way as nicotine and soap, killing the leafhoppers which it hit, but having no lasting effect.

#### ACTION OF BORDEAUX MIXTURE

Bordeaux mixture properly applied to plants will kill nymphs, repel adults, and keep the plants free from them as long as a good coating of spray is kept on the foliage. Unsprayed plants growing next to properly sprayed plants, or even among them, will be heavily attacked by leafhoppers and become badly affected with hopperburn.



FIG. 8.—Fungous disease that checks leafhoppers. The fungus has a rainbowlike appearance after covering the body of the insect

The effect of Bordeaux mixture on hopperburn varies with different varieties. Rural New Yorker potato plants well sprayed have remained almost free of hopperburn until digging time. Triumph potatoes, on the other hand, while they were prevented from becoming badly diseased until after tubers had well developed, were affected much more by hopperburn than any other variety tested. Unsprayed Triumph plants died from the effects of hopperburn before the middle of the season. The five types of potatoes used, in order of their susceptibility to leafhopper attack and to hopperburn, were: Triumph, Irish Cobbler, Early Ohio, Green Mountain, and Rural New Yorker.

## HOW TO PREPARE BORDEAUX MIXTURE

The ingredients and method of preparation of Bordeaux mixture are as follows:

Copper sulphate (bluestone)-----	pounds--	4
Quicklime-----	do-----	4
Water to make-----	gallons--	50

Prepare the copper sulphate or bluestone by suspending it in a gunny sack just below the surface of several gallons of water in a clean barrel. When the bluestone is dissolved, which requires three or four hours, remove the sack and stir into the barrel enough additional water to make exactly 25 gallons of the copper solution.

As the use of quicklime on the farm entails more or less trouble in storing and preparing, many growers are using hydrated lime instead. If it is fresh and of good quality, very good results may be obtained with it. It is easy to keep and to mix, and is usually easy to obtain. Six pounds of it should be used instead of the 4 pounds of quicklime. It should be mixed directly with enough water to make exactly 25 gallons.

If quicklime is used, slake it slowly and thoroughly in a small container, strain into a barrel, and add enough additional water to make exactly 25 gallons of lime milk.

Pour the two ingredients together into another barrel or, better, directly into the spray tank, if it will hold 50 gallons. It is highly important to stir the mixture very thoroughly and to strain both ingredients before they are combined, as otherwise clogging of the spray nozzles may result. Use copper or bronze wire strainer of 18 meshes to the inch. Do not put copper sulphate or Bordeaux mixture into tin or iron vessels; use wood or copper containers. Mix the Bordeaux solution as needed and apply at once. It is never so good after it has settled.

To prepare Bordeaux mixture in small quantities use 1 pound of bluestone, 1 pound of stone lime, or  $1\frac{1}{2}$  pounds of hydrated lime, and  $12\frac{1}{2}$  gallons of water, and proceed according to the directions just given for preparing 50 gallons of Bordeaux mixture, with the exception that smaller containers can be used.

## STOCK SOLUTIONS

Everyone who uses Bordeaux mixture frequently and in quantity will find it convenient to keep on hand concentrated stock preparations of copper-sulphate solution and milk of lime in separate containers. These stock preparations keep indefinitely if the water which evaporates is replaced.

Build an elevated platform to hold the barrels. Some time before the day on which it is desired to commence spraying put 50 pounds of bluestone in a sack and hang it in a barrel with 50 gallons of water, to dissolve. Slake 50 pounds of quicklime, or mix 75 pounds of hydrated lime, in another barrel and add water to make 50 gallons of lime milk. When Bordeaux mixture is needed, stir both stock barrels and take from each as many gallons as the formula calls for in pounds. Dilute the copper sulphate in one barrel and the lime milk in another, each with half the water to be added, and let the two run together into the strainer of the spray tank. Thorough agitation is important in making a good Bordeaux mixture.

## HOW AND WHEN TO APPLY BORDEAUX MIXTURE

To control the potato leafhopper, Bordeaux mixture *must* be applied to the under side of the leaves, and spraying must be done thoroughly, in order to cover practically all of the foliage. Each side of every row of plants must be sprayed (fig. 9).

A high pressure (at least 150 pounds) should be maintained in order to cover the leaves with a fine mist, which gives a much better coating than does a coarse spray (fig. 10).

In years when leafhoppers are abundant at least three applications of Bordeaux mixture should be made, the first as soon as the leafhoppers have appeared on the plants. Where necessary to con-



FIG. 9.—Spraying potatoes properly. A high pressure is needed, and three nozzles should be used for each row, the outer two directing the spray upward and inward. In experiments carefully performed, four such sprayings increased the yield of potatoes 44½ per cent over the yield obtained when two nozzles per row were used, directing the spray downward

trol the Colorado potato beetle, add 1 pound of powdered arsenate of lead to each 25 gallons of the Bordeaux mixture. The second spray should be applied from 10 days to 2 weeks later, depending upon the amount of spray remaining on the plants and the amount of new growth. A third, and even a fourth, spray may be necessary in very hot, dry summers or in years when leafhoppers occur in vast numbers, but the time when these extra applications should be made must be determined by examinations of each field.

As Bordeaux mixture is used for several purposes on potatoes—to repel flea beetles and control certain plant diseases—it is most fortunate that it has been found to be a control for leafhoppers and hopperburn, and it may fit nicely into the regular spraying schedule.



FIG. 10.—The wheelbarrow sprayer is effective for small patches. The boom carries two nozzles

#### SUMMARY OF CONTROL MEASURES

Spraying with Bordeaux mixture appears to be the only practical method of control for the potato leafhopper and for preventing the appearance or spread of hopperburn.

The 4-4-50 formula is generally used.

It should be thoroughly applied to the *under side* of the leaves, at least 150 pounds pressure being used, so that a fine mist spray will result.

Make at least three applications, and spray a fourth time if necessary to keep down hopperburn until the crop has matured.

To make the application thorough, spray both sides of each row.

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